FOLDABLE SUPPORT STRUCTURE HAVING INNER AND OUTER HINGES

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates to portable support structures for use in temporary or permanent fixtures such as trade shows, conventions and display stands, and particularly to a portable truss system having hinges connecting planar wall elements.

2. Description of Related Art.

Commercial displays such as those used in trade show booths require strong structures that can be easily transported and are easily configurable into a wide variety of forms. Such structures need to be lightweight, portable, and able to be quickly set up and broken down.

Prior display structures have contained folding elements that utilize rigid wall members coupled with rotatable wall members. The rotatable wall members allow the display to collapse into a parallelogram shape. The wall members include other pivoting members that serve to lock the display into an open position. Although useful in some applications, this approach has deficiencies. The folded shape is wider than the assembled wall member, which makes the folded assembly difficult to transport and store. Further, it is difficult to provide the pivoting members with a significant locking force to provide the needed stiffness in some applications.

It can be seen that there is a need for a collapsible/foldable truss member that is strong, easy fabricated, and easily assembled into a temporary or permanent structure. The truss member should be foldable into a compact form no wider than the width of the truss member walls. The present invention fulfills these and other needs, and addresses other deficiencies of prior art implementations.

SUMMARY OF THE INVENTION

To overcome the limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a foldable support structure having inner and outer hinges and a truss system having hinges connecting planar wall elements. The portable support structures are adapted for use in temporary or permanent fixtures such as trade shows, conventions and display stands.

An apparatus in accordance with the principles of the present invention includes a truss member including first and second wall members each having an inner surface. Each wall member also includes a substantially planar cross member having opposing sides. The truss member also includes a first and second elongated support member attached to the opposing sides of the cross member. Each support member including at least one elongated hinged pivot member having a first and second end. The first end of the hinged pivot member is rotatably and substantially perpendicularly attached to support members at the inner surface of the wall member. The truss member also includes a plurality of external hinges rotatably coupling the second ends of the hinged pivot members of the first wall member with the second ends of the hinged pivot members of the second wall member. The first and second wall members are disposed so that the inner surface of the first wall member is facing the inner surface of the second wall member. The inner surfaces of the first and second wall members define an inner volume of the truss member. The hinged pivot members are

rotatable to a folded position so that the hinged pivot members are within the inner volume. The hinged pivot members are substantially parallel to the inner surfaces of the wall members.

Other embodiments of a system in accordance with the principles of the invention may include alternative or optional additional aspects. One such aspect of the present invention is that each support member also includes at least one receiving end. The support members are arranged so that the receiving ends of the support members are disposed on one end of the truss member.

Another aspect of the present invention is that the truss member also includes a locking end having an elongated cross bar. The cross bar having opposing ends and first and second joining members attached to the opposing ends of the cross bar. The first and second joining members are removably attachable to the receiving ends of the first and second wall members so that the cross bar spans support members having hinged pivot members joined therebetween. The locking end preventing rotation of the hinged pivot members.

Another aspect of the present invention is that the receiving ends each include an open end of the support members and the joining members each include a protrusion locatable within the open ends of the support members.

Another aspect of the present invention is that the cross members include a substantially elongated lace member. The lace member is formed into a substantially planar shape.

Another aspect of the present invention is that the lace member is folded into a sawtooth shape.

Another apparatus in accordance with the principles of the present invention includes a truss assembly including a plurality of side members each having an inner and outer surface. The side members are adjacently connected so that the inner surfaces of the side members form an inner surface of the truss assembly and the outer surfaces of the side members form an outer surface of the truss assembly. Connections between adjacent side members form a first and second set of diagonal corners. Each side member also includes a substantially planar cross member having opposing sides. The side members also include a first and second elongated support member attached to the opposing sides of the cross member. Each support member is disposed adjacent to a support member of an adjacent side member and forms one corner of the truss assembly. The side members also include at least two inner hinges rotatably connecting adjacent side members forming the first set of diagonal corners of the truss assembly and at least two outer hinges rotatably connecting adjacent side members forming the second set of diagonal corners of the truss assembly. The truss assembly is foldable so that an angle formed by the side members at the first set of diagonal corners is acute and an angle formed by the side members at the second set of diagonal corners is obtuse.

Another aspect of the present invention is that each support member also includes at least one receiving end. The support members are arranged so that

receiving ends of the support members are disposed on at least one end of the truss member.

Another aspect of the present invention is that the truss assembly also includes a locking end having an elongated cross bar having opposing ends and first and second joining members attached to the opposing ends of the cross bar. The joining members are removably attachable to the receiving ends of the first and second side members so that the cross bar spans support members having hinged pivot members joined therebetween. The locking end prevents rotation of the hinged pivot members.

Another aspect of the present invention is that the receiving ends each include an open end of the support members and the joining members each include a post locatable within the open ends of the support members.

Another aspect of the present invention is that the truss assembly also includes at least one locking sleeve. The locking sleeve is attachable to the receiving ends of two adjacent support members at a corner of the truss assembly and prevents relative rotation therebetween.

Another aspect of the present invention is that the cross members include a substantially elongated lace member. The lace member is formed into a substantially planar shape.

Another aspect of the present invention is that the lace member is folded into a sawtooth shape.

Another aspect of the present invention is that the support members have a right-triangular cross sectional shape and an external mating surface along an

elongated side of the support member corresponding to the hypotenuse of the cross sectional shape. Adjacent support members at corners of the truss members are disposed such that mating surfaces of adjacent support members abut each other.

Another apparatus in accordance with the principles of the present invention includes a truss member including a first and second substantially planar wall member. Each wall member including first and second opposing side edges. The wall members are disposed substantially parallel and apart from each other so that the first wall member forms a first side of the truss member and the second wall member forms a second side of the truss member. The side edges of the wall members form corner edges of the truss member. The truss member also includes pivoting means connected to the wall members on each of the corner edges of the truss member. The pivoting means providing a pivotable connection to the wall members about a pivot axis. The truss member also including a first and second elongated pivot member having first and second ends and a primary axis running between the first and second ends. The ends of the first and second pivot members are connected to pivoting means on the first and second sides of the truss member. The pivot members each including folding means allowing folding of the pivot member along a folding axis perpendicular to the primary axis.

Another aspect of the present invention is that the truss member also including locking means connectable between at least two of the corner edges of

the truss member. The locking means are rigid between connected corner edges to prevent relative rotation of the wall members about the pivoting means.

Another aspect of the present invention is that the locking means connects to all of the corner edges of the truss member.

Another aspect of the present invention is that the folding axis of the pivot members and the pivot axis of the pivoting means are parallel to the corner edges of the truss member.

The foregoing objects, advantages and distinctions of the invention, among others, are obtained in a presently preferred construction that provides a truss system having hinges connecting planar wall elements.

These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there are illustrated and described specific examples of an apparatus in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

Fig. 1 illustrates a perspective view of a foldable truss according to an embodiment of the present invention;

Fig. 2 illustrates an end view of the foldable truss assembly of Fig. 1 according to an embodiment of the present invention;

Fig. 3 illustrates an end view of the foldable truss illustrating folding of the truss of Fig. 1 according to an embodiment of the present invention;

Fig. 4 illustrates an end view of the foldable truss of Fig. 1 in a completely folded orientation according to an embodiment of the present invention;

Fig. 5 illustrates an exploded perspective view a foldable truss having a plurality of locking ends according to an embodiment of the present invention;

Fig. 6 illustrates an exploded perspective view a foldable truss having a pair of locking frames according to an embodiment of the present invention;

Fig. 7 illustrates an end view of the foldable truss assembly of Fig. 6 according to an embodiment of the present invention;

Fig. 8 illustrates an end view of the foldable truss showing folding of the truss of Fig. 6 according to an embodiment of the present invention;

Fig. 9 illustrates an end view of the foldable truss of Fig. 6 in a completely folded orientation according to an embodiment of the present invention;

Fig. 10 illustrates an end view of the foldable truss assembly having triangular support members according to an embodiment of the present invention;

Fig. 11 illustrates an end view of the foldable truss showing folding of the truss of Fig. 10 according to an embodiment of the present invention;

Fig. 12 illustrates an end view of the foldable truss of Fig. 10 in a completely folded orientation according to an embodiment of the present invention;

Fig. 13 illustrates a perspective view of a locking sleeve attached to a truss member according to an embodiment of the present invention;

Fig. 14 illustrates a cross sectional view corresponding to section 1-1 of Fig 3 according to an embodiment of the present invention; and

Fig. 15 illustrates a perspective view of a locking sleeve attached to a truss member having triangular cross-section support members according to an embodiment of the present invention.

While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail herein. It is to be understood, however, that the invention is not limited to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the claims appended hereto.

DETAILED DESCRIPTION OF THE INVENTION

In the following description of the illustrated embodiments, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration, various embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized, and structural and functional changes may be made without departing from the scope of the present invention.

The present invention provides portable support structures for use in temporary or permanent fixtures such as trade shows, conventions and display stands, and particularly a portable truss system having hinges connecting planar wall elements.

Fig. 1 illustrates a perspective view of a foldable truss according to an embodiment of the present invention. In Fig. 1, the foldable truss member 100 includes two wall members 102. Each wall member 102 includes at least two support members 104 and a cross member 106 joining the support members 104. Support members 104 may be made from any elongated material. In this example, support members 104 are formed from a square, metallic tubing, however, the support members may be formed from other materials such as, plastic or corrugated cardboard. The cross members 106 may also be formed from an elongated tube or rod material. The material forming the cross members 106 is shaped into a substantially planar "lace", in this configuration a V-shaped pattern or sawtooth shape. Alternatively, the cross members 106 can be formed

from sheet metal, expended metal, a mesh material or other types of materials and shapes.

The wall members 102 are joined by hinged pivot members 108 that provide a foldable connection between wall members 102. In this arrangement, the support members 104 form corner edges of the truss member 100. Each pivot member 108 is joined to a support member 104 by an inner hinge 110. In this embodiment, the hinged pivot member 108 and inner hinge 110 are attached so that the hinged pivot member 108 is rotatable about an axis parallel to the corner edges of the truss member 100. The hinged pivot members 108 are foldable inwards, i.e., the end 111 of the hinged pivot member 108 opposite the hinge 110 rotates toward an inner surface of the truss member 100. The inner surface of the truss member 100 is defined by inner-facing surfaces of the wall members 102. The hinged pivot members 108 of opposing wall members 102 are joined at ends 111 by an outer hinge 112. The inner and outer hinges 110, 112 may be an off-the-shelf variety attachable hardware or may be formed from features (e.g. notches) on the hinged pivot members 108 and/or support members 104.

Figs. 2-4 illustrate how the hinged pivot members 108 operate to fold the truss member 100. Fig. 2 is an end view of the truss member 100 in a deployed, unfolded, state. In Fig. 3, the hinged pivot members 108 are rotated in the directions indicated by the curved arrows. As seen in Fig. 3, the width of the truss member 100 decreases while the length remains the same during folding. Fig. 4 shows the completely folded truss member 100. The size of storage and

shipping containers will be much smaller due to the reduction in size of the truss member in the completely folded state. In the folded position, the hinged pivot members 108 are situated between and parallel to the inner surfaces of the wall members 102.

It is appreciated that rotations of the hinged pivot members 108 about the inner hinges 110 may occur along any arbitrary pivoting axis. It is preferable that the outer hinge 112 of the hinged pivot member 108 remain within an inner volume of the truss member 100 during folding. However, alternate mechanisms can serve as inner hinges 110 (e.g. ball joints) that may not restrict rotation of the hinged pivot members 108 about an axis parallel to the support members 104. In such a case, the hinged pivot members 108 can have alternate folded orientations other than that shown in Fig. 3. For example, the inner hinge 110 may allow rotation such that the hinged pivot members 108 are vertically disposed and parallel to the support members 104 when the truss member 100 is folded rather than horizontally disposed.

Fig. 5 is a perspective view of a truss member 100 according to another embodiment of the present invention. The hinged pivot members 108 in this embodiment have substantially the same cross sectional size as the support members 104. A pair of locking ends 502 are shown attached to receiving ends 501 of the support members 104. The locking ends 502 prevent the hinged pivot members 108 from rotating inwards, and thereby prevents folding of the truss assembly 100. The locking ends 502 have protrusions (e.g. posts) 504 that fit within the ends of the support members 104. The protrusions 504 can extend

from two or more sides of the locking ends 502, thereby allowing the connection of multiple truss members 100 into a larger combination structure. The protrusions 504 are joined by a cross bar 506 that provides stiffness that prevents folding of the hinged pivot members 108.

Fig. 6 shows an alternate embodiment of a truss member 600 according to an embodiment of the present invention. The truss member 600 includes multiple side members 602 including support members 104 and cross members 106. The side members 602 may be fabricated similar to the wall members 102 described previously. The side members 602 are arranged adjacently such that lower edges of the side members 602 form a closed loop. The inner surfaces of the adjacent side members 602 form an inner surface of the truss member 600, and the outer surfaces of the side members 602 form an outer surface of the truss member 600.

Adjacent side members 602 are connected by inner hinges 604 and outer hinges 606. The inner hinges 604 are attached to adjacent side members 602 at diagonal corners of the truss member 600. The outer hinges 606 are attached to adjacent side members 602 at the other diagonal corners. The inner and outer hinges 604, 606 connect the adjacent side members 602 and work cooperatively to allow the side members 602 to pivot relative to each other.

The inner and outer hinges 604, 606 work cooperatively to allow the truss member 600 to fold into a parallelogram shape. The truss member 600 in this embodiment does not have the same folded profile as the previous embodiments, however, the truss member 600 of this embodiment may be

advantageously formed from substantially identical side members 602. The use of identical side members 602 as opposed to hinged pivot members 108 allows the truss assembly 600 to be formed from fewer parts, thereby significantly reducing costs.

In the deployed, unfolded state, as shown in Fig. 6, the truss member 600 may be structurally stabilized by use locking frame 610. Locking frame 610 is similar to locking ends 502, as shown in Fig. 5, however, locking frame 610 stabilizes all four corner of the truss member in both linear and transverse directions. The locking frame 610 is provided with protrusions 612 (e.g., posts) which may be received into open ends of support members 104. The protrusions are connected by four cross bars 614. The locking frame may also be provided with diagonal support joists 616 to increase the structural stability and overall strength of the deployed truss member 600. Locking frames 610 may be attached at both the top and bottom of the truss member 600. The locking frames also facilitate building of larger structures utilizing a combination of truss members stacked vertically in the unfolded, deployed state.

Figs. 7-9 illustrate how the inner and outer hinges 604, 606 work cooperatively to allow the truss member 600 to fold into a collapsed state for storage or transportation. Fig. 7 is an end view of the truss member 600 in a deployed, unfolded, state. In Fig. 8, folding of the truss member 600 is shown where at least two of the wall members 602 are rotated, as indicated by the curved arrows. As seen in Fig. 9, the completely folded truss member 600 forms a generally flat assembly for ease of storage, shipping and transportation.

Figs. 10-12 illustrate a truss assembly 600 according to another embodiment of the present invention. The support members 104 are formed from elongated members having a right-triangular cross section. The support members 104 have a mating surface 601 that corresponds to the hypotenuse of the triangular cross section. In the deployed, unfolded state, shown in Fig. 10, the mating surfaces 601 of adjacent support members 104 abut each other so that the corners of the truss member 600 have a generally square or rectangular cross sectional shape. Inner and outer hinges 604, 606 are disposed abutting corners of adjacent side members 602 and provide a pivotable connection therebetween.

In Fig. 11, folding of the truss member 600 is shown where at least two of the wall members 602 are rotated as indicated by the curved arrows. As seen in Fig. 12, the completely folded truss member 600 forms a generally flat assembly having a substantially rectangular cross sectional shape. This substantially rectangular shape allows folded truss members 600 to be more easily stacked. for storage, shipping and transportation.

In Fig. 13, a locking sleeve 1300 is shown that can be used to hold a truss member 600 in the deployed configuration. The locking sleeve 1300 includes a first end 1302 that fits over the receiving ends 501 of two adjacent support members 104 along axis 1-1 and a second end 1306 for receiving an end of another truss member when stacked to form a larger combination structure. As best seen in Fig. 14, the locking member 1300 may include at least one stop member 1304 preventing the locking member 1300 from sliding too far over the

end of the support member 104. In Fig. 15, a locking member 1300 is shown that is configured to restrain a truss member 600 having triangular support members 104, as previously described in relation to Figs. 10-12.

It is appreciated that a single locking sleeve 1300 can be used to prevent the truss member 600 from folding, although it may be preferred to utilize a plurality of locking sleeves 1300, i.e., one on each corner of the truss member 600. The locking sleeves 1300 prevent relative rotation of adjacently pivoted support members 104, therefore the plurality of locking sleeves 1300 need not be interconnected with cross bars as previously shown in Figs. 5 and 6, however, it may be desirable to join a plurality of locking sleeves 1300 together in an arrangement similar to locking ends 502 or locking frame 610 for further strength and/or ease of installation. Joining locking sleeves 1300 into an end unit or frame also allows for easier forming of a structure with truss members 600. To join truss members 600 into a structure, a second truss member 600 can be introduced into the second end 1306 of locking sleeve 1300.

The foregoing objects, advantages and distinctions of the invention, among others, are obtained in a presently preferred construction that provides a truss system having hinges connecting planar wall elements.

The foregoing description of the exemplary embodiment of the invention has been presented for the purpose of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It

is intended that the scope of the invention be limited not with this detailed description, but rather by the claims appended hereto.